

# The Fox Project: Advanced Development of Systems Software

R&D Status Report  
January 1 to March 31, 1999

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The long-term objectives of the Carnegie Mellon Fox Project are to improve the design and construction of systems software and to further the development of advanced programming language technology. We use principles and techniques from the mathematical foundations of programming languages, including semantics, type theory, and logic, to design and implement systems software, including operating systems, network protocols, and distributed systems. Much of the implementation work is conducted in the Standard ML (SML) language, a modern functional programming language that provides polymorphism, first-class functions, exception handling, garbage collection, a parameterized module system, static typing, and a formal semantics. This Project involves several faculty members and spans a wide range of research areas, from (1) advanced compiler development to (2) language design to (3) software system safety infrastructure.

## **1 Research Progress**

We report on the research accomplishments during the first calendar quarter of 1999, and the research objectives for the second quarter of 1999.

### **Accomplishments (January-March):**

- Finished implementation of cost VCGEN for SAL code. This allows Proof-Carrying Code to certify time bounds on program execution, which is critical for Active Network applications.
- Developed cost VCGEN for Java bytecode.
- The PML compiler now correctly compiles most of the expressions in its source language (Modal ML). Only a few features remain to be added and a little debugging to be done.
- Improved the TILT compiler architecture to reduce compilation time to a practical level.
- Devised and implemented a dialect of Typed Assembly Language suitable as a target for the TILT compiler.

### **Objectives (April-June):**

- Complete the first public release of TILT/ML compiler.

- Implement cost VCGEN for Java bytecode and apply this to active networking problems in conjunction with Darwin project.
- Implement a SPARC back-end with threads for the TILT compiler and a parallel garbage collector.
- Continue progress on Touchstone/Linux port.
- Begin research on the ability of the type system of Typed Assembly Language (TAL) to express different compiler optimizations.
- Finish measuring the Foxnet performance.
- Finish Foxnet performance technical report.
- Complete the last few features of the PML compiler. Performance testing of generated code, possible improvements.
- Link the TILT compiler with the new dialect of TAL, resulting in the first fully typed compiler for ML. This compiler will be capable of certifying its output executables for safety in mobile code and extensible system applications.
- Complete the first implementation of a meta-theorem prover for LF which can handle hypothetical reasoning.

## 2 Noteworthy Publications

- *Bounding Time and Space for Parallel Garbage Collection* by Guy Blelloch and Perry Cheng. Accepted for publication in PLDI '99.
- *From System F to Typed Assembly Language* by Greg Morrisett, David Walker, Karl Crary and Neal Glew. Accepted for publication in ACM Transactions on Programming Languages and Systems.
- *TALx86: A Realistic Typed Assembly Language* by Greg Morrisett, Karl Crary, Neal Glew, Dan Grossman, Richard Samuels, Frederick Smith, David Walker, Stephanie Weirich and Steve Zdancewic. Accepted for publication in the 1999 Workshop on Compiler Support for System Software.
- *A Simple Proof Technique for Certain Parametricity Results* by Karl Crary. Submitted for publication. Also published as technical report CMU-CS-FOX-98-06.

### **3 Capital Equipment Purchases**

- 2 IBM Thinkpads 600 Model, 300 Mhz, \$6,452.00

### **4 Key Personnel Changes**

- None.

### **5 Noteworthy Meetings**

- DARPA QUORUM/HCC PI meeting (Atlanta, GA, February 16-18, 1999).  
Attended by Frank Pfenning and Karl Crary.
- 1999 Symposium on Principles of Programming Languages (POPL '99) (San Antonio, TX, January 20-22, 1999).

### **6 Administrative Data**

Base Funding (excludes options): 5,630,798

Funded Options:

UNFunded Options: 648,704

Total Funding Provided to Date (both base and options): 3,617,974

Total Funding Expended to Date (both base and options): 3,390,305

Total Funding UNExpended: 227,669

Date Current Funding will be Expended: 30 JUN 1999

Funding Expended in Most Recent Quarter: 225,890

Incremental Funding required for FY 1999: 800,000

Date of Financial Data: 31 MAR 1999